Space Weather Technical Forecast

Issued on Sunday, 11 December 2022 at 12:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: No Earth-bound CMEs were observed in the period. Solar activity has been Low over the past 24 hours, with several C-class flares. The largest of these flares was a C5.2 observed at 10/1611 UTC from AR3163 near the southeastern limb. There are currently ten sunspot regions on the visible disc. The largest region on the disc, AR3153, remains stable with little activity. AR3163 in the southeast has a large leader followed by several smaller trailing spots. The final larger spot group, AR3157, remains unchanged in recent hours. The remaining sunspot regions are relatively small, weak and magnetically simple, and generally stable. Three sunspot regions in the southern hemisphere are unnumbered with the most notable in the southwest which is developing rather quickly with rapid flux emergence.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were indicative of the waning effects of the fast wind emanating from CH53/-. The solar wind speed was slightly elevated with a flat trend and some variability noted . The solar wind density was near or rather below average levels. The IMF was weak and followed a declining trend. The phi angle was negative (towards the Sun) for much of the period. The net result of the above solar wind measures was Quiet to Unsettled geomagnetic activity (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Background to occasionally Moderate levels. The associated 24-hour fluence remained well below Active (1e8 integrated pfu). Observed fluence at 11/0000UTC was 1.73e6 integrated pfu with a slowly rising trend at GEO.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of isolated M-class flares each day, currently most likely from AR3163, but AR3153 or AR3157 remain moderately large and complex. Further arriving regions into the coming UTC working week may see a further development of activity.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. Solar winds are likely to remain at Slightly Elevated levels, with a possible declining trend. There is a Chance of solar winds reaching Elevated levels due to the influence of an unnumbered coronal hole on day 3 (13th), before trending back to Slightly Elevated levels by the end of the period. The geomagnetic forecast is therefore expected to be mainly Quiet (Kp 0-2) with a Chance of isolated Unsettled or Active intervals (Kp 3-4), mainly on day 3 (13th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to remain at Background levels throughout, with a daily Very Slight Chance of seeing

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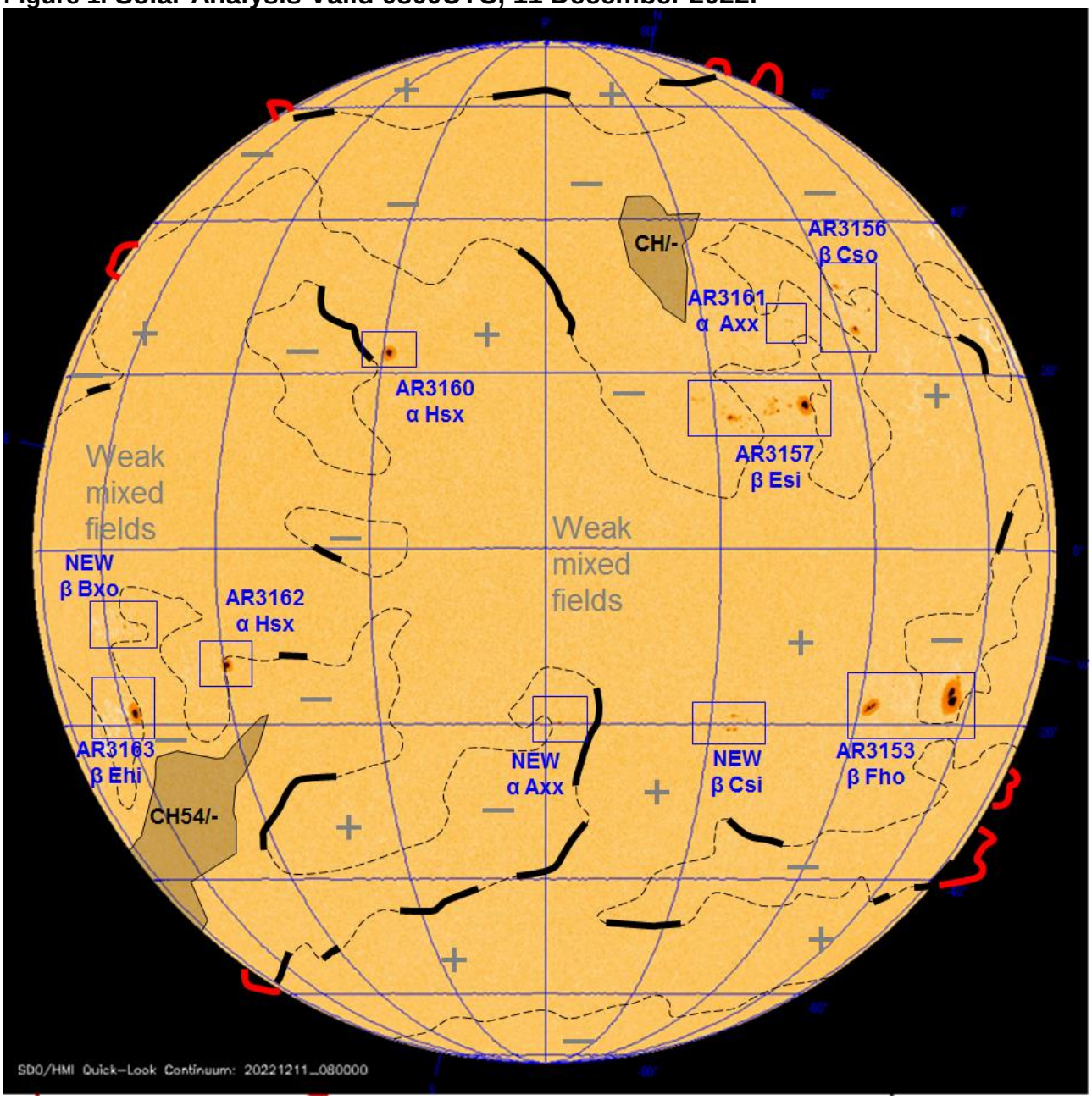
S1+ levels if any significant flares were to occur. High energy electron flux (greater than 2 MeV) is expected to remain at predominantly Background to Moderate levels, but with an increasing trend, which brings a chance of occasional High levels (1000 pfu) being reached at times through the working week UTC from day 2 (12th) onwards . The corresponding high energy electron fluence is expected to remain below the Active (1e8 integrated flux) threshold, despite the suggested eventual upward trend, which is also currently observed.

Figure 1. Solar Analysis Valid 0800UTC, 11 December 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

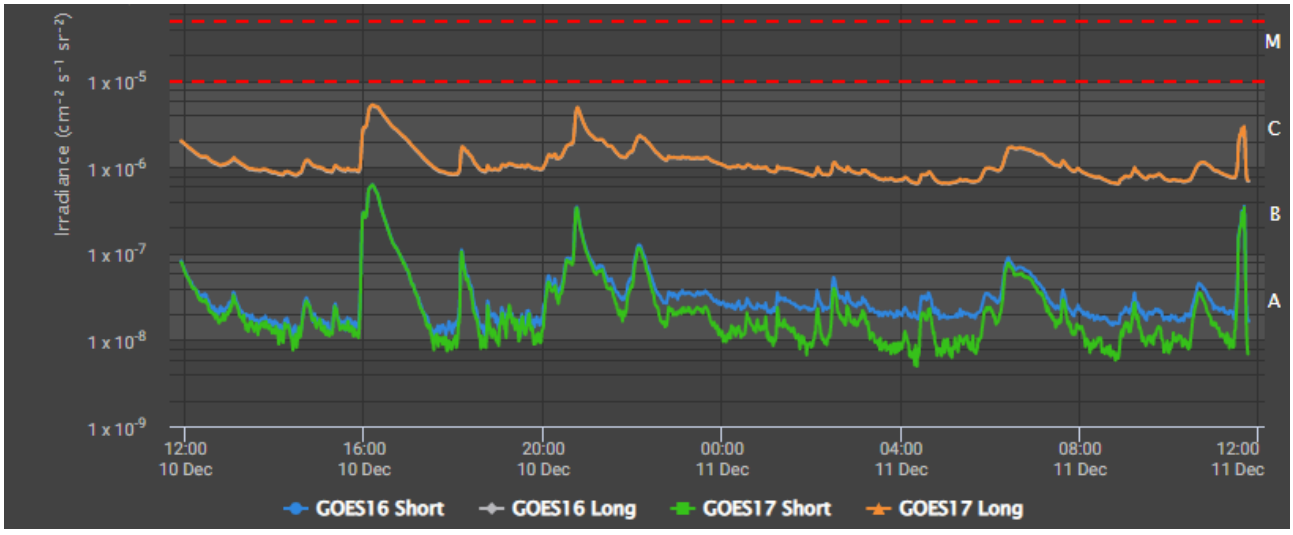
No Earth-directed CMEs feature in the current forecast.
The solar wind is currently under the remaining influence of CH53. Looking upwind to STEREO A, the satellite suggests solar winds could remain at slightly elevated levels (i.e. around 450km/s), but a declining trend in the solar wind speed is probable during day 2 (12th). Coronal hole calculations and MOSWOC Enlil then suggests that a negative polarity unnumbered coronal hole may become geoeffective through the course of the UTC day of 13 December. There was a similarly-located coronal hole present here on last rotation (13 November), however this did not produce noteworthy geomagnetic activity. This fact, coupled with our proximity to the solstice should limit any resulting effects from this feature, though a residual Very Slight Chance has been catered for within the forecast. The geomagnetic forecast is therefore likely to be mainly Quiet with a Chance of isolated Unsettled or Active intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Latest x-ray flux plot at GEO with several C-class flares over past 24 hours.



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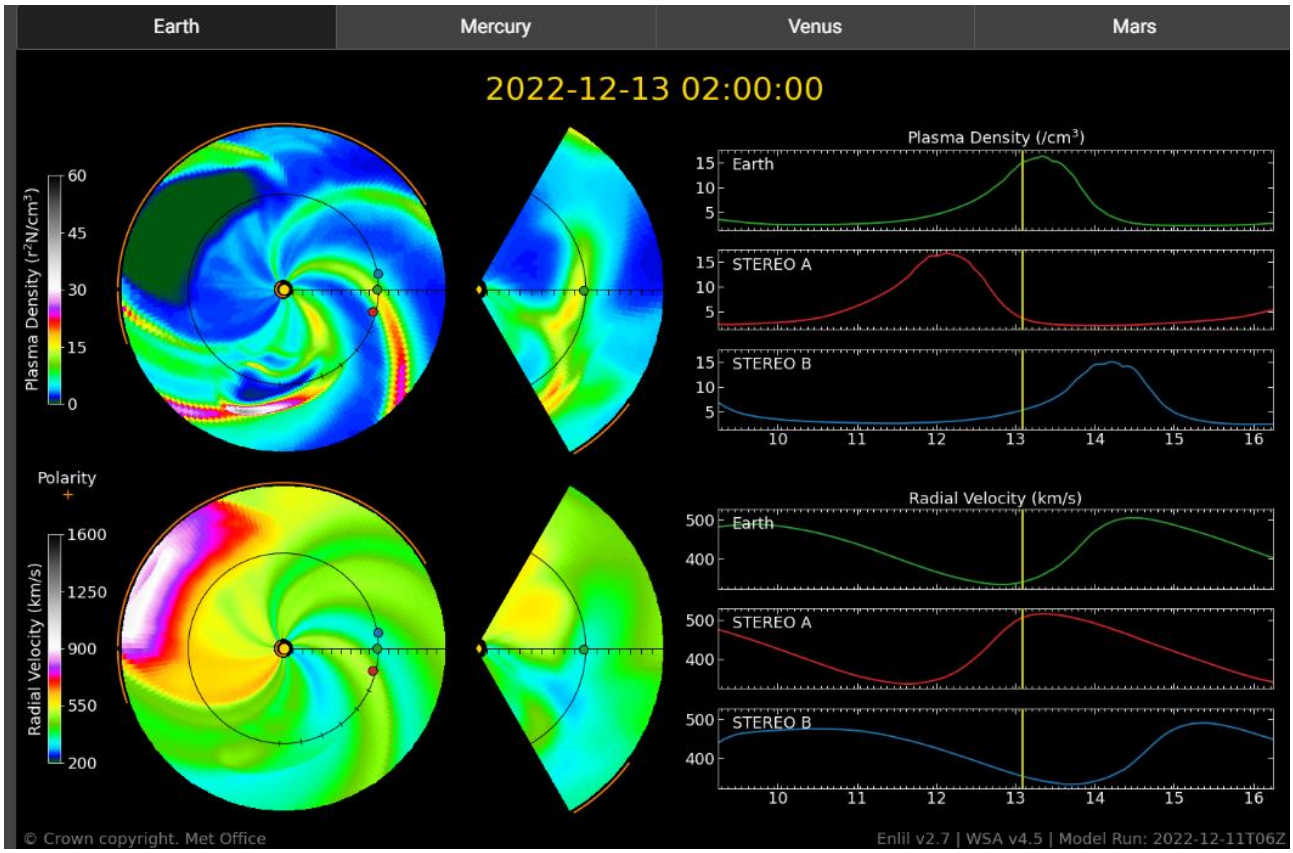
Radio Blackouts - X-Ray Flares:

There are currently seven numbered sunspot regions on the visible disc, including the newly-designated AR3163 in the far southeast. This sunspot region has been the main cause of the observed uptick in solar activity, with a flat trace near the boundary of B and C-class flux at GOES16 giving way to occasional mid-ranking long period C-class flares and mostly eastward-directed CMEs. The Carrington locations for Ex-3147, 48 and 49 are all due over the eastern solar horizon into the start of the forthcoming UTC working week, and as such the probabilities of X-ray flares may increase. No significant regions leave the Earth-facing side in the four days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Met Office ENLIL output showing the next high speed to affect Earth due around 13th.



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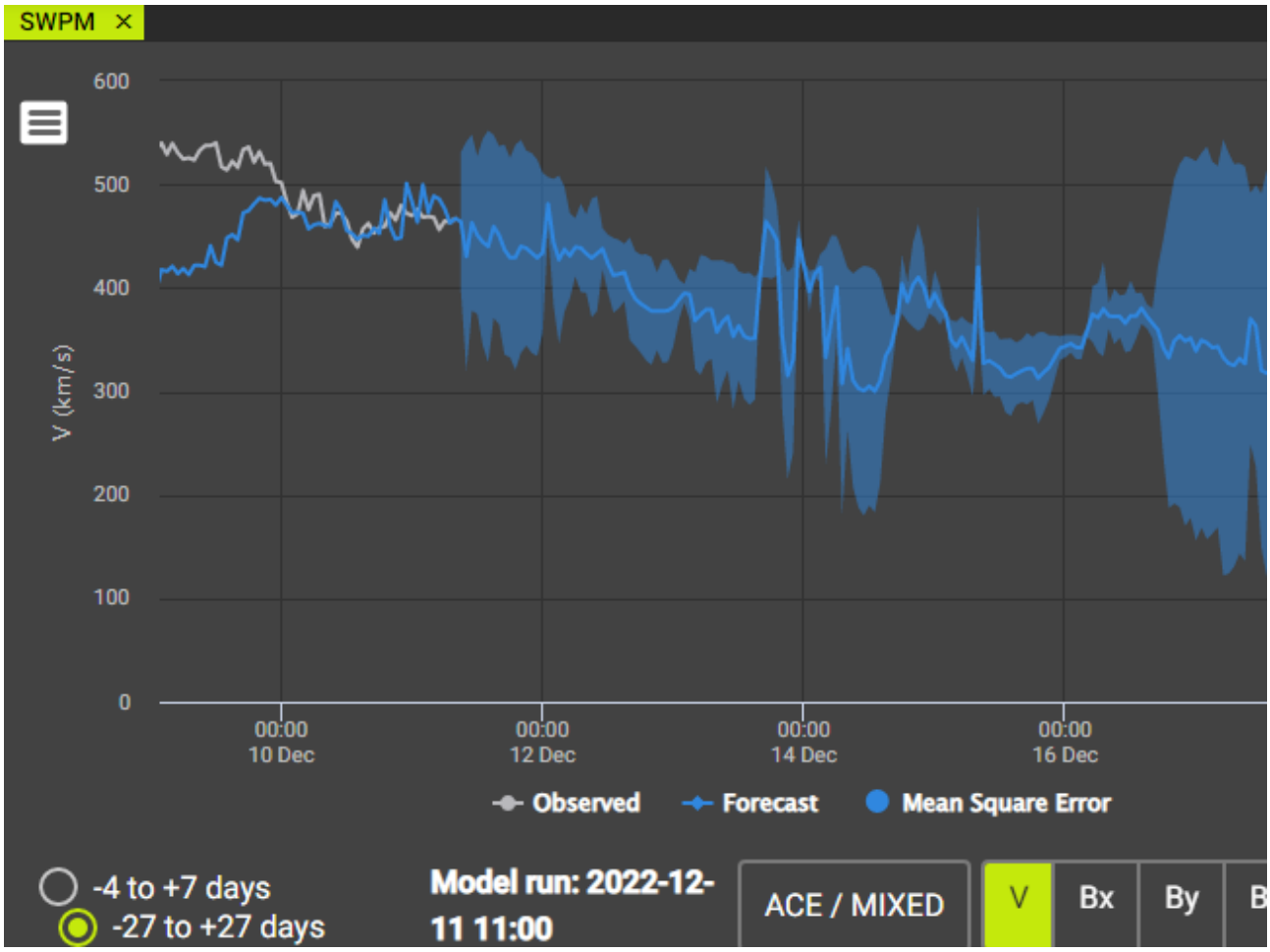
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is most likely to remain at Background levels throughout. There remains a daily Very Slight Chance of seeing S1 or greater levels at GEO if any significant flares were to occur. The 5% risk is mainly due to the nominal presence of the three larger sunspots on the Earth facing disk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Met Office Solar Winds Prediction Model (SWPM), with a mostly declining trend in solar winds.



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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV) will probably rise in the next 24 to 48 hours due to recently Elevated solar winds from ongoing HSS influence, and the fact that associated geomagnetic activity is probably diminishing. This uptick in activity brings a chance of occasional High levels (1000 pfu) being reached at times through the working week UTC from day 2 (12th) onwards. MOSWOC Enlil remains steadfast in suggesting that a new high speed stream ought to arrive sometime day 3 (13th). This hole is a negative polarity feature that extends down from the northern hemisphere towards the solar equator. This may serve to dent electron counts through the second half of the forecast period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	30	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at observed at GEO and Met Office REFM output.

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